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REVIEW OF THE BOOK: WALDEMAR NAWROCKI, INTRODUCTION TO QUANTUM METROLOGY (IN POLISH)

Quantum metrology is a field of theoretical and experimental study of high-resolution and high-precision methods of measurement of physical parameters based on quantum mechanics, and particularly exploiting quantum entanglement. Without equivalent in classical mechanics, quantum entanglement of particles or other quantum systems is an unusual phenomenon in which the state of a system is determinable better than the state of its parts. Attempts are made to use new measurement strategies and physical systems in order to attain measurement precision never achieved so far.

Currently the major field of practical application of quantum metrology is the construction of measurement standards based on quantum effects. These are primary universal standards available on the global scale since they allow to reproduce the magnitude of a given unit at any place of the globe by measurements yielding equal results anywhere in appropriate conditions. The creation of quantum standards of the base units of the International System (SI) is in accordance with the objectives laid out by the International Committee for Weights and Measures (CIPM) and realized in collaboration with the International Bureau of Weights and Measures (BIPM).

The textbook under review presents the theory of quantum effects used in electrical metrology and results of the Author's own research in the field of quantum electronics. In contrast to *Zjawiska kwantowe w metrologii (Quantum Effects in Metrology)*, an earlier book by W. Nawrocki, written with M. Wawrzyniak and published in 2003, the present book discusses also measurement standards used in other branches of metrology, such as those of mass, length, time and frequency. It is the first comprehensive survey of quantum metrology problems in Polish literature of the subject, the scarcity of which did not prevent, however, the realisation of quantum standards from being initiated in Poland, with the contribution of the Author, who carried out measurements of the Josephson effect-based quantum standard of voltage in the Polish Central Office of Measures in 2001.

Providing a clear presentation of practical application of the effects used in quantum metrology for the construction of quantum standards and sensitive electronic

components, the book is very useful for a wide audience of experimenters and metrologists in the broad sense of both terms. However, first and foremost it is an academic textbook and cannot be overestimated as such because of its entirely new approach to metrology and electrical metrology, both of which are subjects taught in technological courses.

The book opens with a discussion of the theoretical grounds of quantum metrology including the limitations of measurement accuracy implied by the theoretical physics, namely the Heisenberg uncertainty principle and the existence of energy resolution limits (Chapter 1). Providing the rudiments of metric systems, Chapter 2 discusses the currently adopted standards representing SI units, and the changes in the classical system of measures allowed by quantum metrology. Chapters 3, 5, 7, 8 and 9 present the theory and practical realisations of quantum standards of measure of various quantities: the voltage standard (using the Josephson effect), the resistance standard (exploiting the Hall effect), the frequency standard (based on transitions between energy levels in atoms), the length standard (using a laser interferometer) and the mass standard (based on the masses of atoms and particles). Chapters 4 and 6 deal with sensitive electronic components and detectors based on quantum effects and including, among others, superconducting quantum interference magnetometers (SQUID), single electron tunnelling transistors (SETT) and advanced voltage/frequency quantum converters with Josephson junction.

The description of the discussed devices and the underlying physical effects is complemented by a presentation of methods and principles of comparing quantum standards (with the time standard used as example) in accordance with the hierarchy of the system of standards. Not omitting the achievements of the Polish Central Office of Measures and Polish constructors, the book also cites Polish and international metrology documents in force.

The textbook is at the same time an up-to-date and inspiring monograph, which certainly brings a contribution to the scientific progress. As a scientific survey it puts in order the fundamental problems related to electrical metrology, the universal primary standards and the measuring procedures recommended by BIPM. As an academic textbook, it propagates a new approach to metrology, with more emphasis laid on its connection with physics, which is of much importance for the constantly developing technologies, and nanotechnology in particular.